



## Original Paper

# Flora of Espírito Santo, Brazil: Bixaceae

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### Abstract

The present study is part of the Flora of Espírito Santo project and aimed to survey and describe the morphological diversity of species of Bixaceae from Espírito Santo state, Brazil, as well as to provide data on geographical distribution, biology, and habitat of these species. To do so, fieldwork was carried out in several areas of Espírito Santo and the most important herbaria collections in the state were examined. Bixaceae in Espírito Santo is represented by the genus *Bixa*, with two species. *Bixa atlantica*, recently described and repeatedly misidentified as *Bixa arborea*, is a forest tree up to 20 m tall (rarely appearing as treelet or shrub in savannah-like vegetation), with spine fruits and lacking nectaries in the pedicel apex. *Bixa orellana*, on the other hand, is recognized as a shrub or treelet up to 5–6 m tall, with conspicuous nectaries in the pedicel apex. The species origin is uncertain, though it occurs sub-spontaneously in Espírito Santo state, where it is widely cultivated due to its value as a spice. In this paper we provide taxonomic descriptions, an identification key, geographic distribution maps, photographic plates and comments on the ecology, conservation, and recognition of both species.

**Key words:** Atlantic Forest, *Bixa*, Malvales, neotropical flora, taxonomy.

### Resumo

O presente trabalho é parte do projeto Flora do Espírito Santo e objetivou levantar e descrever a diversidade morfológica das espécies de Bixaceae deste estado, assim como prover dados da distribuição geográfica e comentários sobre a biologia e o habitat das espécies. Diversas expedições de coleta foram conduzidas no Espírito Santo e os herbários com as coleções mais importantes do estado foram examinados. Bixaceae no Espírito Santo é representada pelo gênero *Bixa* com duas espécies. *Bixa atlantica*, recentemente descrita e repetidamente identificada incorretamente como *Bixa arborea*, é uma árvore de floresta com até 20 m de altura (raramente arvoreta ou arbusto em vegetação savanoide), com frutos espinescentes e nectários no ápice do pedicelo ausentes. *Bixa orellana* é reconhecida por ser um arbusto ou arvoreta com 5–6 m de altura, com nectários conspícuos no ápice do pedicelo. A espécie é amplamente cultivada por seu uso como condimento e possui origem incerta, mas ocorre espontaneamente no estado do Espírito Santo. Aqui, fornecemos descrições taxonômicas, uma chave de identificação, mapas de distribuição geográfica, pranchas fotográficas e comentários sobre a ecologia, conservação e reconhecimento para ambas as espécies.

**Palavras-chave:** Floresta atlântica, *Bixa*, Malvales, flora neotropical, taxonomia.

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## Introduction

The Bixaceae family comprises four genera and 20–26 species, has a pantropical distribution, and is especially diverse in the Neotropics. *Amoreuxia* Moç. & Sessé is composed of four species distributed in Mexico and South USA (Stevens 2022); *Bixa* L. is composed of five to seven species distributed in tropical America, especially in the Amazon (Dequigiovanni *et al.* 2018; Antar *et al.* 2022); *Cochlospermum* Kunth is composed of 12–15 species distributed in the Americas, Africa, Asia, and Oceania (Johnson-Fulton & Watson 2017; WCVP 2022); and *Diegodendron* Capuron is monotypic and endemic to Madagascar (Bayer 2002). The species of Bixaceae occur predominantly in seasonal climates, inhabiting deciduous or semi-deciduous forests, tropical forests, natural grasslands, savannahs, and sometimes, disturbed environments (Poppendieck 1981, 2002a,b; Stevens 2022).

Bixaceae has traditionally been recognized as monogeneric, composed exclusively of *Bixa*, while the other genera currently placed within Bixaceae have been treated in separated families: *Amourexia* and *Cochlospermum* in Cochlospermaceae, and *Diegodendron* in Diegodendraceae (Bayer 2002; Poppendieck 2002a,b). Phylogenies based on molecular characters supported the placement of all these members within Bixaceae (APG IV 2016; Fay *et al.* 1988). This hypothesis is currently widely accepted (Stevens 2022), although it is not a consensus, as a concurrent phylogenetic hypothesis (Johnson-Fulton & Watson 2017) advocated the separation of Cochlospermaceae. The lack of consensus indicates that further studies on these taxa are needed.

In Brazil, Bixaceae is represented by seven species and two genera, *Bixa* and *Cochlospermum* (Antar 2022; Antar *et al.* 2022). These taxa have been the subject of recent floristic studies, which resulted in the publication of some treatments (*e.g.*, Kirazawa 2002; Antar & Sano 2016; Fernandes-Júnior & Gil 2017; Ribeiro & Loiola 2017; Antar *et al.* 2020; Antar & Sano 2022). In the state of Espírito Santo, Brazil, Bixaceae is represented by two species of the genus *Bixa*, *B. atlantica* Antar & Sano and *B. orellana* L., both of which are the subject of this study.

## Materials and Methods

This study is based 1) on the analysis of material collected in field expeditions carried

out since 2010 in several areas of Espírito Santo, and 2) on the comparative analysis of herborized specimens deposited in the botanical collections ESA, MBM, MBML, RB, SAMES, SPF and VIES (acronyms according to Thiers, continuously updated). Additionally, virtual collections, accessed via SpeciesLink (2022) and Re flora Herbário Virtual (2022), were examined. To identify and describe the taxa, specialized bibliography was used (Baer 1976; Antar *et al.* 2022). Author names and species nomenclatures follow IPNI (2022). The morphological characters used in the descriptions follow the terminology of Hickey (1973) for leaf morphology, Harris & Harris (2004) for general terms, and Baer (1976) for terms unique to Bixaceae. The species occurrences were obtained by consulting herbarium data, and the distribution maps were produced using the QGIS software, version 3.10.0 (QGIS Development Team 2019). Only non-cultivated individuals (natural or spontaneous) were considered.

## Results and Discussion

The flora of Bixaceae in Espírito Santo state is represented by two species, *Bixa atlantica* and *B. orellana*. *Bixa atlantica* occurs in semideciduous forest, *tabuleiro* forest, and sometimes in disturbed secondary forest or along forest edges and modified lands in savannah-like physiognomies. The species is able to grow among rocks at the bottom of valleys. The species also occurs in the states of Bahia and Minas Gerais, but most gatherings are from Espírito Santo. Specimens of *Bixa atlantica* have often been referred to as *Bixa arborea* Huber, an Amazonian species that clearly differs from *B. atlantica* in having spineless fruits (Antar *et al.* 2022). This misidentification was reproduced in published articles (*e.g.*, Vieira Neto *et al.* 2012; Klippel *et al.* 2015; Spadeto *et al.* 2017), and only recently resolved (Antar *et al.* 2022). The species was evaluated as Near Threatened due to its endemic distribution in the forest physiognomies of Espírito Santo, Bahia and Minas Gerais, a distribution pattern that links its conservation with the conservation of the Atlantic Forest, a domain under severe threats due to habitat loss by agriculture and urbanization (Rezende *et al.* 2018). In addition to several unprotected areas, *Bixa atlantica* occurs in three protected areas in Espírito Santo: Reserva Biológica de Sooretama, Reserva Biológica Córrego do Veado, and Reserva Natural Vale (Linhares).

*Bixa orellana*, on the other hand, is widely cultivated in tropical regions and its occurrence is documented for all Brazilian states. Although sometimes it can be hard to infer the proper origin of the individuals of *Bixa orellana* (i.e., whether cultivated or sub spontaneous), some collections - as *Crepaldi 114* (RB 441580) - confirm the

occurrence of the species in natural formations in Espírito Santo, mostly in areas of secondary forest. Thus, in view of its wide distribution and cultivation, there is little evidence of threats to its conservation.

### Taxonomic treatment

#### Key to the species of Bixaceae that occur in Espírito Santo

1. Trees, treelets or rarely shrubs, up to 20 m tall; leaf base rounded, truncate or rarely slightly cordate; nectaries in the pedicel apex absent, rarely inconspicuous; fruits wider than long ..... 1.1. *Bixa atlantica*
- 1'. Shrubs or treelets 5–6 m tall; leaf base cordate or truncate; nectaries in the pedicel apex present, conspicuous; fruits longer than wide ..... 1.2. *Bixa orellana*

#### Bixaceae Kunth.

Herbs, subshrubs, shrubs, treelets or trees, frequently with reddish or orange exudate; subterranean system occasionally thickened, forming a xylopodium. Branches cylindrical, sometimes with nectaries in foliar nodes. Leaves simple or palmately compound, entire or palmatilobed, alternate, petiolate, deciduous or perennial, margin entire or serrate, venation actinodromous; petiole sometimes pulvinate at base and apex; stipules frequently deciduous. Inflorescence terminal, rarely axillar, thyrses, panicle or raceme; bracts early deciduous. Flowers conspicuous, monoclinal, actinomorphic, rarely zygomorphic, dichlamydeous, heterochlamydeous, hypogenous, pedicelate; pedicel occasionally with glands or extrafloral nectaries; calyx frequently deciduous, sepals free, (4)5(6)-merous, imbricate, deciduous or persistent, lobes equal or unequal; petals free, 5(6)-merous, rose, white or yellow, aestivation imbricate or contorted, lobes equal or subequal; stamens numerous, connate at base or free, anthers biteous, basifixed, dehiscence rimose or poricidal; ovary superior, syncarpous, 2–5-carpelar, uniloculate or 3–5-loculate, ovules numerous, anatropous, placentation parietal or axial at base, style unique, gynobasic or terminal, stigma denticulate, entire or lobate, nectariferous disc present between androecium and gynoecium. Fruit capsule loculicidal or schizocarp, dehiscent or rarely indehiscent, unarmed or with flexible spines. Seeds 1-numerous, glabrous to lanate, turbinate, cocleate, globose or reniform, seed coat carnosose or not.

#### 1. *Bixa* L.

Trees up to 30 m tall, treelets or shrubs, orange or reddish exudate present, young branches, leaves and fruits with peltate trichomes. Branches cylindrical, pair of extrafloral nectaries in foliar nodes. Leaves simple, entire, perennial, membranous, chartaceous or rarely coriaceous, margin entire; petioles developed, pulvinate at apex and base; stipules linear to lanceolate, early deciduous. Inflorescence terminal, paniculate; bracts early deciduous, present at the inflorescence ramification, leaving a conspicuous transversal scar, extrafloral nectaries 1, located below the bract scars. Flowers actinomorphic; pedicel with five extrafloral nectaries at the apex of the pedicel, conspicuous, inconspicuous or absent; calyx early deciduous, sepals imbricate, 5, subequal or unequal; corolla rose or white, petals imbricate, 5, equal or subequal; stamens free or connate at base, anthers curved, horse-shaped, poricidal, with two linear pores at apex; ovary unilocular, bicarpelate, ovules with parietal placentation, style terminal, stigma lobate. Fruit capsule loculicidal, 2-valvar, dehiscent or indehiscent, with flexible or unarmed spines, spines obscuring the fruit surface or not. Seeds numerous, turbinate, glabrous, orange to red, seed coat carnosose.

*Bixa* comprises four to six species distributed in Tropical America, especially in the Amazon region (Baer 1976; Antar *et al.* 2020). *Bixa orellana* is widely cultivated and naturalized in some tropical localities (Poppendieck 2002b). From four to five species occur in Brazil, depending on whether *Bixa urucurana* Willd. is a valid name (Baer 1976; Steyermark & Holst 1997) or a synonym of *B.*

*orellana* (Lleras 2015; Dequigiovann *et al.* 2018). *Bixa atlantica* is the only species of the genus that is endemic to Brazil (Antar *et al.* 2022).

**1.1. *Bixa atlantica*** Antar & Sano, Phytotaxa 544(2): 173 (2022). Figs. 1-2

Trees or treelets 6–20 m tall, rarely shrubs. Stems with lenticels, indument with scattered peltate trichomes, becoming denser, mostly stalked and ferruginous near the inflorescence, the older stems glabrescent or glabrous, stipule scar evident, transversal, narrow, with two circular nectaries beneath it. Leaves subcoriaceous to chartaceous, discolorous with abaxial surface lighter, blade narrow ovate, lanceolate or, less commonly, ovate, (7.6–)9.9–22.3 × (2.9–)4.1–12.5 cm, base rounded,

truncate or rarely slightly cordate, apex acuminate to long acuminate, margin entire, adaxial surface with scattered peltate trichomes, mostly forming depressed small pits concentrated near the main veins, rarely densely disposed, abaxial surface with scattered peltate trichomes distributed all over the surface, venation with (4–)5 primary veins at each side of the midrib, the lowest at approximately 1/4 of the midrib length; petioles 2.1–9.7 cm long, with scattered peltate trichomes; stipules soon deciduous, lanceolate, apex acuminate to long acuminate, 5.9–8.5 × 1–1.8 mm, abaxial surface with peltate trichomes externally, except at base and margins, adaxial surface glabrous. Inflorescence 25–45 flowered, densely covered with ferruginous, stalked, peltate trichomes; bracts

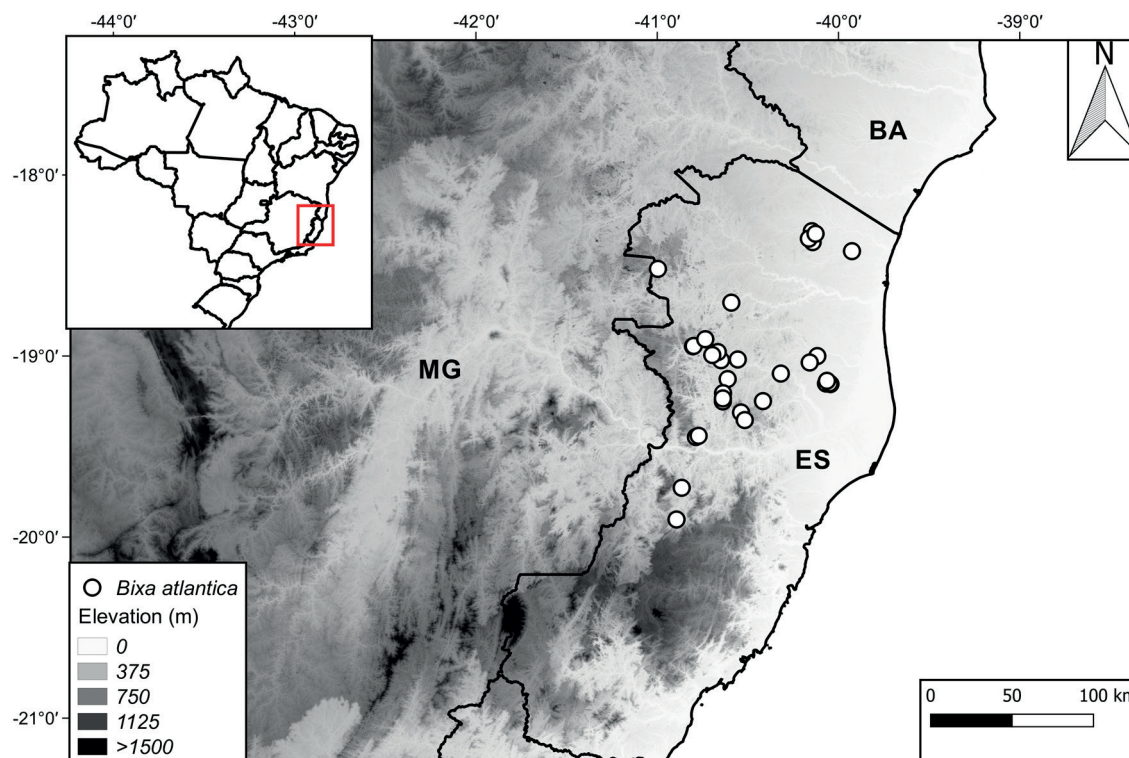


**Figure 1** – a-d. *Bixa atlantica* – a. branch bearing flowers; b. branch bearing fruits; c. fruits; d. branches bearing fruits (Photos: b-d. Guilherme Medeiros Antar; a. Cíntia Hencker).

soon caducous, 2.2–3.6 mm long, ovate, apex acute, glabrescent with few peltate hairs, mostly near the base; nectaries below bract scar, glabrous, sometimes inconspicuous due to the indumentum. Flowers 3–5 cm diam.; pedicel 5.9–11.5 mm long, densely covered with ferruginous, stalked, peltate trichomes, extrafloral nectaries at the apex of the pedicel absent, rarely inconspicuous; calyx cream-colored to brownish, sepals concave, 6.6–7.8 × 6.9–7.4 mm, wide ovate or orbiculate, apex obtuse, base truncate, abaxial surface pubescent to glabrescent with peltate hairs, mostly near the base, adaxial surface glabrescent with peltate hairs, mostly near the base; corolla white, petals subequal, membranous, glabrous, 16–23 × 10–15 mm, obovate, apex obtuse, base cuneate to truncate; stamens vinaceous with the mid-portion whitish and the base yellowish, unequal, the ones at the base 3.5–6.5 mm long, the others 8.5–11.5 mm long, filaments glabrous, anther ca. 1 mm long; ovary ovoid to hemispherical, densely covered with peltate trichomes, ca. 2.5 × 2–2.5 mm, style 7.0–8.5 mm long, glabrous. Fruit dehiscent, reddish, becoming brownish when older, 1.2–1.7 × 2.0–2.8 cm, hemispherical or widely ovoid, apex

rounded, densely covered with ferruginous, stalked, peltate trichomes, spines densely disposed but not obscuring the fruit surface, 11–13 mm long, erect, subulate, base enlarged, rarely branched; peduncle 1.1–2.0 cm long. Seeds 5–5.3 × 5–5.5 mm, ellipsoid or spheroid, brownish to blackish.

**Specimens examined:** Água Doce do Norte, 27.IV.2008, *L. Kollmann et al. 10952* (MBML, SPF). Águia Branca, assentamento 16 de Abril, 18°54'25.3"S, 40°44'5"W, 150–200 m, 15.III.2006, *V. Demuner et al. 1953* (MBML, SPF). Águia Branca, assentamento 16 de Abril, fragmento à esquerda do campo, 18°54'25.3"S, 40°44'5"W, 200–400 m, 16.III.2006, *V. Demuner et al. 2011* (MBML, SPF); córrego do Trinta (CEIER), proprietário: Alex Sandro, 19°1'22.2"S, 40°38'52.8"W, 170–500 m, 25.IV.2006, *V. Demuner et al. 2187* (MBML, SPF); córrego Taquaral, Santa Luzia, propriedade José Rocinha, 18°59'39"S, 40°41'46"W, 200–350 m, 2.IV.2007, *V. Demuner et al. 3442* (MBML, SPF); Rochedo, propriedade Arlindo Breda, 18°56'45"S, 40°48'10"W, 400–550 m, 16.V.2007, *V. Demuner et al. 3912* (MBML, SPF); idem trilha do córrego, propriedade Ailton Corteleti, 18°56'39"S, 40°47'55"W, 380–560 m, 6.IX.2006, *L.F.S. Magnago et al. 1317* (MBML, SPF); Santa Luzia, propriedade Ciro Ferreira, 18°58'40"S, 40°39'56.1"W, 170–300 m, 4.VII.2007, *R.R. Vervloet et al. 2789* (MBML, SPF). Colatina, Jequitibá (Torre



**Figure 2** – Geographic distribution of *Bixa atlantica* in the state of Espírito Santo, Brazil.

45/2 - LT 230 Kv) Mascarenhas x Verona, 19°14'2.3''S, 40°38'16.1''W, 240 m, 15.VII.2008, *A.M. Assis & K.F.O. Faria 1703* (MBML, SPF); idem, 19°15'2.3''S, 40°38'16.1''W, 240 m, 23.V.2008, *A.M. Assis & K.F.O. Faria 1674* (MBML, SPF); São João Grande (Torre 15/2 - LT 230 Kv Mascarenhas x Verona), 19°26'50.1''S, 40°47'11''W, 300 m, 16.X.2008, *A.M. Assis & V. Pereira 1823* (MBML, SPF); (Torre 18/1 - LT 230 Kv Mascarenhas x Verona), 19°26'25.5''S, 40°46'16.9''W, 200 m, 15.X.2008, *A.M. Assis & V. Pereira 1810* (MBML, SPF). Conceição da Barra, Cobraice - Fazenda Jundiá, 18°25'14.3''S, 39°55'31.6''W, 50 m, 28.IX.1998, *A.M. Assis & L.F.D. Valentin 1804* (MBML, SPF). Governador Lidemberg, Alto Moacir, propriedade Vitório Salomão, 19°18'42''S, 40°32'15''W, 350-630 m, 21.II.2006, *L.F.S. Magnago et al. 682* (MBML, SPF). Itaguaçu, localidade de Cachoeirão, 27.II.2006, *R.C. Britto et al. 26* (MBML, SPF). Itarana, Fragmento localizado na comunidade do Baixo Sossego, 15.II.2011, *C. Hencker et al. 56* (MBML, SPF). Linhares, Reserva da Companhia Vale do Rio Doce, borda da trilha da Bicuíba, 55 m, 4.IV.2006, *J.G. Rando et al. 150* (ESA). Linhares, Reserva de Linhares, Docemade, 1.II.1972, *D. Sucre 8350* (MO, NY, RB); Reserva Florestal da Companhia Vale do Rio Doce, córrego João Pedro, aceiro com José Velascio, 26.IV.1990, *L.P. Queiroz 2479* (CEN, HUEFS); Reserva Florestal da CVRD, acesso à casa de hóspedes, 22.VIII.1996, *A.L.B. Sartori et al. 213* (CVRD, UEC); Reserva Florestal de Linhares-Cia. Vale do Rio Doce, estrada do Flamengo, ca. 500 m da sede, 19°9'6''S, 40°4'8''W, 64 m, 11.V.2000, *J.R. Pirani et al. 4674* (RB, SPF); Reserva Natural da Vale, trecho de mussununga próximo ao nativo do contorno do Roxinho, 17.IV.2011, *D.F. Lima et al. 210* (BHCB, CTES, CVRD, ESA, HUEFS, RB). Marilândia, Alto Liberdade, propriedade Deuclecio Lorenzini, 19°21'13''S, 40°31'1''W, 300-400 m, 19.IV.2006, *L.F.S. Magnago et al. 899* (MBML, SPF). Pinheiros, Reserva Biológica Córrego do Veado, trilha de educação ambiental, 18°22'15''S, 40°8'32''W, 113 m, 1.II.2007, *L.M. Versieux et al. 399* (SP, SPF); Santa Rita, 18°18'37''S, 40°8'49''W, 107 m, 31.I.2008, *L. Kollmann & L. Magnago 10521* (MBML, SPF); Reserva Biológica Córrego do Veado, estrada, 1.VI.2010, *M. Ribeiro et al. 179* (SAMES); estrada que circunda a reserva, 18°21'5''S, 40°9'48''W, 23.V.2022, *G.M. Antar et al. 4437* (SAMES). Rio Bananal, Alto município de Rio Bananal, 19°14'56''S, 40°24'59''W, 300-450 m, 1.VIII.2007, *R.R. Vervloet et al. 3106* (MBML, SPF); arredores de São Jorge de Tiradentes, 19°5'48.2''S, 40°19'4.9''W, 7.X.2017, *E.D. Lozano et al. 3882* (MBM, SPF). São Domingos do Norte, São Gonçalo (Torre 48/2 - LT 230 kv Mascarenhas x Verona), 19°12'17.8''S, 40°38'12.3''W, 244 m, 3.V.2008, *A.M. Assis & K.F.O. Faria 1656* (MBML, SPF); trevo para Águia Branca (Torre 58/2 - LT230 Kv Mascarenhas x Verona), 19°7'37''S, 40°36'41''W, 150 m, 2.V.2008, *A.M. Assis & K.F.O. Faria 1611* (MBML, SPF). São Gabriel da Palha, Fazenda Rondeli, próximo

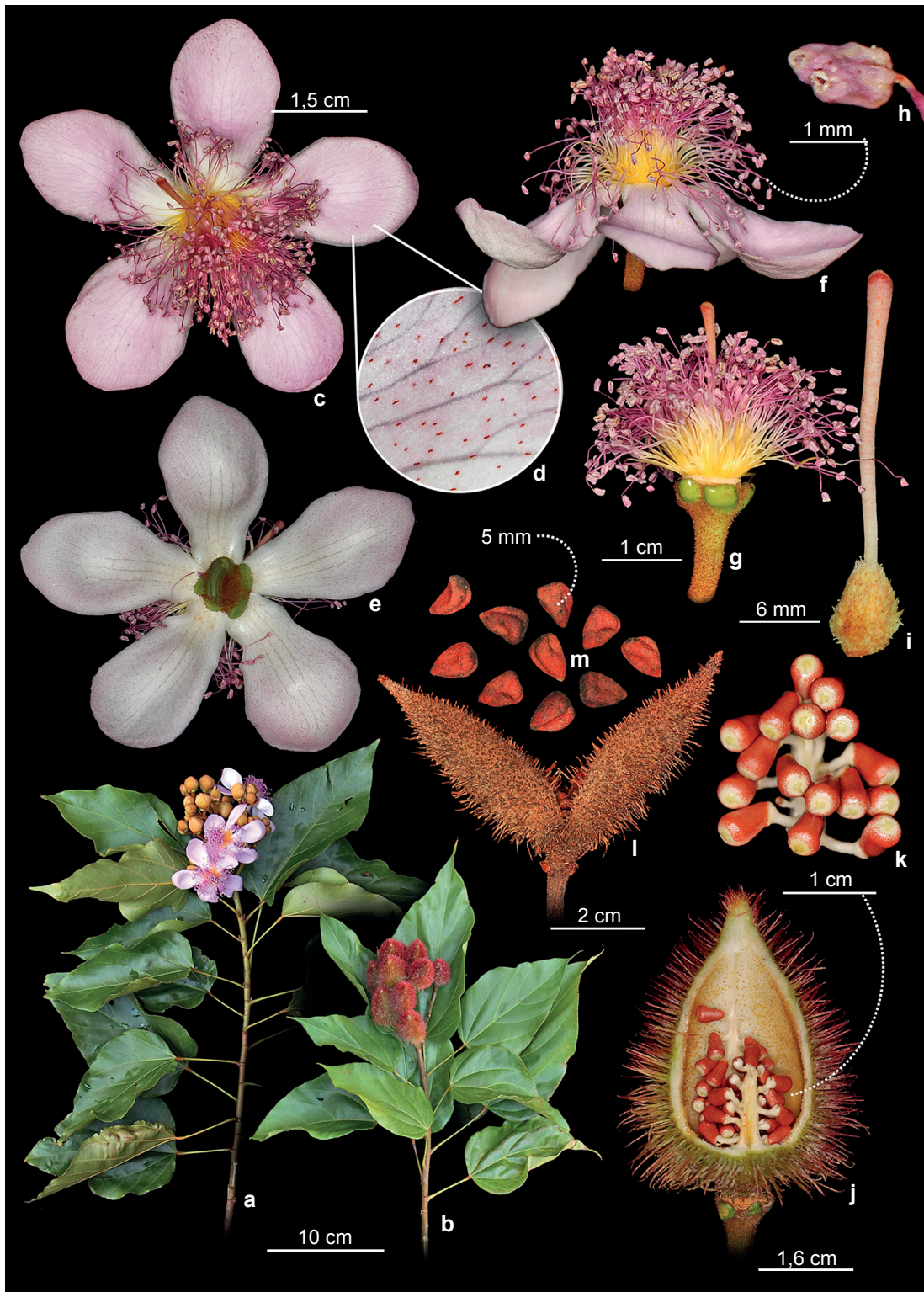
ao clube campestre, 19°1'8''S, 40°33'19.5''W, 200 m, 26.IV.2008, *A.M. Assis & V.G. Demuner 1565* (MBML, SPF). Sooretama, Reserva Biológica de Sooretama, 74 m, 9.X.2012, *M.B. Costa 18* (SAMES, VIES); idem, porção oeste, trilha do barro roxo, 18.I.2010, *A.G. Oliveira et al. 705* (SAMES).

*Bixa atlantica* is most closely related to *B. excelsa* Gleason & Krukoff, endemic to the Amazonian domain. The two species can be differentiated by the leaf venation [(4–)5 primary veins in *B. atlantica* vs. 3(–4)], petal color (white in *B. atlantica* vs. rose), fruit color (reddish in *B. atlantica* vs. greenish or brownish) and fruit spine density (not obscuring the surface in *B. atlantica* vs. obscuring the surface).

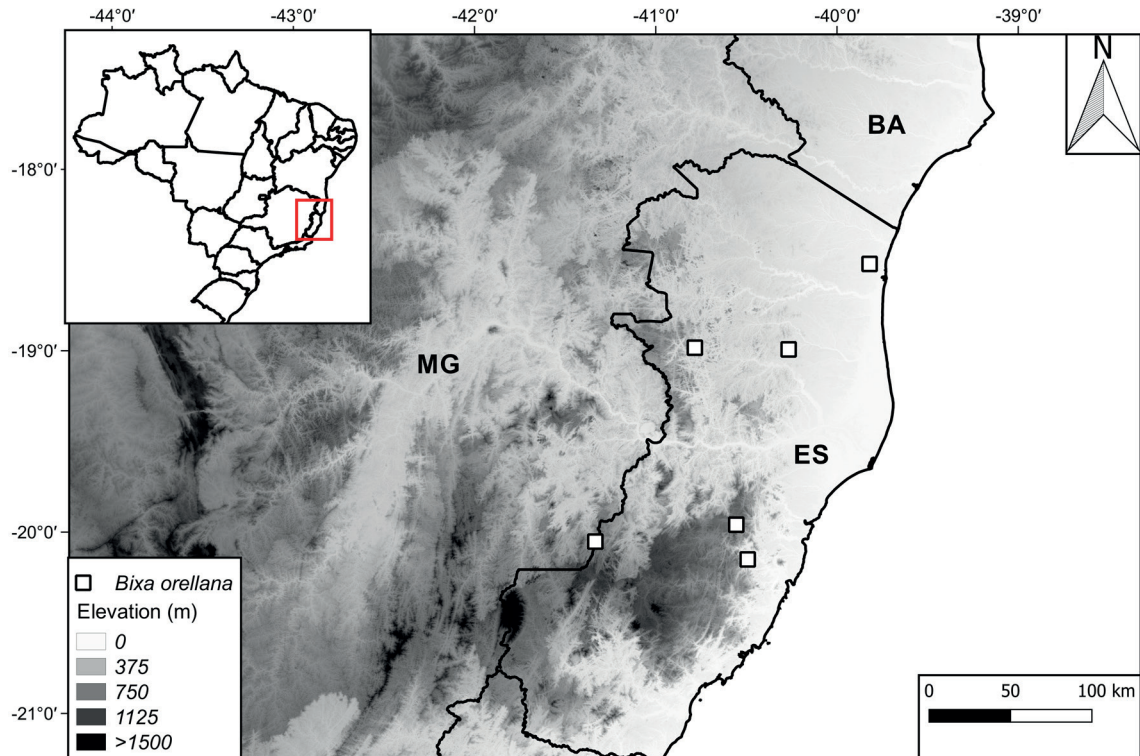
## 1.2. *Bixa orellana* L., Sp. Pl. 1: 512. 1753.

Figs. 3-4

Trees up to 5 m tall, rarely shrubs. Stems with lenticels, indument with peltate trichomes of different heights, denser and ferruginous in younger branches, the older stems glabrescent or glabrous, stipule scar evident, transversal, narrow, with two circular nectaries below it. Leaves membranous to chartaceous, discolorous with abaxial face lighter, blade ovate, 7.7–18.3 × 4.6–12.1 cm, base rounded, truncate or cordate, apex acuminate, margin entire, adaxial surface glabrous or with few peltate trichomes mostly near the veins, abaxial surface with sparse scattered peltate trichomes, venation with 4–5 primary veins on each side of the midrib, the lowest at approximately 1/4 of the midrib length; petiole (2.7–)4.5–6.9 cm long, with scattered peltate trichomes; stipules linear 1.0–1.5 × 1–2 mm, early deciduous, adaxial surface glabrous, abaxial surface with densely arranged peltate circular trichomes. Inflorescence 7–25 flowered, densely covered by stalked, peltate trichomes; bracts early deciduous, 5.1–8 mm long, ovate, apex acute, glabrescent with few peltate hairs, mostly near the base. Flowers 3–5 cm diam.; pedicels 5–12.5 mm long, densely covered with ferruginous, stalked, peltate trichomes; 5 extrafloral nectaries at the apex of the pedicel, conspicuous, circular, ovate or with irregular shape; calyx castaneous or brown, sepals concave, 8–13 × 6.4–9.5 mm, wide ovate, apex obtuse, mucronate, base truncate, abaxial face densely covered with peltate, non-stalked, trichomes, adaxial face glabrescent; corolla rose or whitish, petals subequal, membranous, glabrous, 1.8–2.6 × 1.0–1.6 cm, obovate, apex obtuse or rounded, base cuneate to truncate; stamens rose with the mid-



**Figure 3** – a-m. *Bixa orellana* – a. branch bearing flowers; b. branch bearing fruits; c. flower, upward view; d. detail of petal surface; e. flower, downward view; f. flower, side view; g. flower, side view, without sepals and petals, highlighting the pedicel nectaries; h. anther; i. gynoecium; j. immature fruit, longitudinal cut; k. immature seeds; l. opened fruit; m. mature seeds. (Photos: a-l. Danilo Alvarenga Zavatin).



**Figure 4** – Geographic distribution of *Bixa orellana* in the state of Espírito Santo, Brazil.

portion whitish and the base yellowish, subequal, 7–11 mm long, filaments glabrous, anther ca. 1 mm long; ovary ovoid to subglobose, densely covered with peltate trichomes, ca. 3 × 4 mm, style 14–15.5 mm long., glabrous. Fruit dehiscent at apex, greenish to reddish, becoming brownish to blackish when older, (2)3–4 × 2.5–3.5 cm, ovoid or spheroidal, apex acuminate, covered with peltate stalked or sessile trichomes, spines densely disposed but no obscuring the fruit surface, 3–9 mm long, erect, subulate, base enlarged, rarely branched; peduncle 1.2–1.9 mm long. Seeds 4–5 mm × 3 mm, turbinate, reddish.

**Specimens examined:** Águia Branca, Parque Natural Municipal Recanto do Jacaré, morro com macega e reflorestamento, 18°58'59"S, 40°44'25"W, 23.IV.2004, *A.M. Assis & K.F.O. Faria 1026* (MBML, SPF). Conceição da Barra, 18°31'16"S, 39°46'34"W, 13.XI.2012, *J.M. Ferreira 38* (SAMES); Comunidade Linharinho: Quinta Vanusa (morro), 9.VII.2011, *M.G.S. Fink 87* (SAMES, VIES). Santa Leopoldina, distrito de Mangaraí, Cachoeira do Retiro, 20°9'2"S, 40°26'55"W, 1.V.2006, *M.O.S. Crepaldi 114* (RB). Santa Teresa, Santa Lúcia, 26.IV.1984, *W. Boone 72* (MBML, SPF). Vargem Alegre, Patrimônio (lugarejo), *H.M. Ferreira* (RB00059679).

*Bixa orellana* is unique within the genus due to the combination of shrub or treelet habits (up to 5 m tall), pedicel with 5 conspicuous extrafloral nectaries at the apex, and fruits with spines. As for morphology, the closest species is *Bixa platycarpa* Ruiz. & Pav. ex G.Don., which is sometimes treated as a synonym (Lleras 2015); both species share characteristics such as conspicuous nectaries at the pedicel apex, but *Bixa platycarpa* is a forest tree reaching up to 30 m tall and showing different fruit morphology. This species has no record in Brazil (Baer 1976).

As a widely cultivated species, the origin of *Bixa orellana* remains controversial, although *Bixa urucurana* (sometimes treated as *B. orellana* var. *urucurana*) stands as a potential candidate for a non-domesticated species from which *B. orellana* was selected (Dequigiovanni et al. 2018).

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